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The Central Question

On what major fronts has the science of ecology progressed during the last 35 years?

The Background Question

What defines progress in science?

A Background Observation

Ecologists have two broad objectives:
- to promote an ecological world view
- to understand ecological systems

The first is an ethical and philosophical commitment, the second scientific

Outline

Why write a textbook
- The background of Ecology
- Distribution
- Abundance: Population ecology
- Abundance: Community ecology
- Human ecology
- The Bottom Line

Why write a textbook?

- Dissatisfaction with the current texts available in the 1960s
- An strong commitment to the Eltonian approach to ecology
- Lectures set the stage for a textbook if one follows through
The Background of Ecology

- My heroes in the late 1950s were Charles Elton at Oxford, H.G. Andrewartha at Adelaide, and Charles Birch at Sydney
- Textbooks were in short supply

The Major Question

- What controls the distribution and abundance of organisms?

Distribution - # 1

- The key question: what controls the geographical distribution of organisms?
- This question almost predates ecology - e.g. Warming (1896) on plants
- In 1963 T.T. Macan in England had laid out a hierarchical decision tree to answer this question

Macan’s Hierarchy for Analyzing Distributions

Distribution - # 2

- Major change is the appreciation of scale-dependent answers
- Habitat selection has flourished in the last 35 years
- Climate as a limitation on geographic distributions has become a paradigm
**Distribution - # 3**

- **Dispersal** as a limitation on distribution has emerged as the critical issue of invasive species (Elton 1958)
- **Macroecology** of range sizes first began in 1980s
  - abundance vs. range size

**Population Abundance**

- **Population arithmetic** has expanded on the basics already described by 1960
- **Disease** was put on the population agenda about 1980
- The basics of population dynamics have not changed in 35 years

**Applied Population Problems**

- **Pest control** and harvesting have changed little conceptually
- **Conservation biology** was put on the agenda about 1985 and first appeared in the 4th edition (1994)

**Behavioural Ecology**

- Did not exist in 1970 as a subdivision of ecology
- **Ethologists** studied animal behaviour and were more akin to psychology than biology
- One of the fastest growing areas of ecology in 1980s and 1990s

**Evolutionary Ecology**

- A small area of ecology in the 1960s
- Life-history theory had arisen from Cole’s 1954 paper
- r- and K-selection was introduced in 1970
- Coevolution and group-selection were key topics in 1960s / early 1970s

**Community and Ecosystem Ecology - # 1**

- The major issues in community ecology were already visible in 1970
  - succession
  - primary and secondary production
  - species diversity
  - stability
Community and Ecosystem Ecology - # 2

- Major changes in orientation
- Biodiversity has taken centre stage
- Focus in 1960s on energetics – the Odum approach
- Equilibrium and non-equilibrium concepts collided in mid-1980s

Community and Ecosystem Ecology - # 3

- In 1970 everyone believed that communities were equilibrium assemblies structured by competition
- Disturbance ecology began to gather steam in the 1980s and did not appear until the 4th edition (1994)
- Nonequilibrium viewpoint became prominent in the 1980s

Ecosystem Ecology - # 1

- In 1970 the predominant view of ecosystems was as energy processors
- Nutrient cycling became increasingly important when climate change and greenhouse gases were recognized as threats to humans
- Ecosystem services was coined by Paul Ehrlich in 1983 and developed in the 1990s

Human Ecology

- Human population was a strong area of concern already by the late 1960s
- Climate change did not appear as an index term in 1st edition
- Sustainable development did not appear on the horizon until the mid-1980s
  - The Bruntland Report of 1987

New Developments since 1972

- Mathematical models were present but in their infancy
- Systems analysis was big in the 1950s but already falling from grace by the 1960s
- Landscape ecology was present only as a part of wildlife management

New Technology since 1972

- Computers have made a large impact
- DNA technology has allowed new questions to be asked
- Remote sensing has been strongly developed but a mixed blessing
- Radio-telemetry has opened up new types of data collection
Old Technology since 1972
- Plant sampling methods have changed little
- Mark-recapture trapping has had minor improvements
- Insect and invertebrate sampling has changed little
- Technological improvements with aquatic sampling

Laws of Population Ecology
- Malthusian Law (geometric growth)
- Allee’s Law (feedback)
- Verhulst’s Law (competition)
- Hutchinson’s Law (interacting species)
- Liebig’s Law (limiting factors)

Laws of Community Ecology
- We do not seem to have a similar list of laws in community and ecosystem ecology

Bandwagons of Ecology
- 1950s - Density-dependence
- 1960s - Energy flow, Stability-Diversity
- 1970s - Competition
- 1980s - Mathematical modeling
- 1990s - Disturbance, non-equilibrium
- 2000s - Biodiversity, complex systems

The Eternal Challenge
- Ecologists wish to develop a robust, general theory of ecological systems
- All the research to date points in the opposite direction –
  - results are local and specific
  - generality difficult to achieve

The Bottom Line - # 1
- The same problems face ecologists in 2005 as they did in 1970
- Major progress in technical tools
- Much progress in analytical statistical and mathematical methods
- Increasing number of ecologists

Berryman (2003), Oikos 103: 695-701.
The Bottom Line - # 2
- Ecology does not differ from physics and chemistry in conceptual progress
- Confusion in discussions of progress between science and technology
- Key ecological issues now are practical
  - conservation of biodiversity
  - sustainability

The Bottom Line - # 3
- Ecology differs from other sciences in being in opposition to the dominant economic paradigm
- Politicians and too many of the public do not wish to hear about problems
- Solutions to major ecological issues are largely 'no brainers'
  - land clearing, overgrazing, CO₂

Key Ecological Issues for this Century
- Can modern agriculture become sustainable?
- How can biodiversity be best conserved?
- How will changing climate affect ecosystem dynamics?

What Can Ecologists Do?
- Keep asking interesting, critical scientific questions
- Promote systems-based research with research teams
- Educate the public about ecological truths, which rarely coincide with economic or political truths

Thanks for listening!